

Evaluation of the Index of Biotic Integrity and Its Use Describing the Fisheries
Community in Bell Creek, Delaware County IN

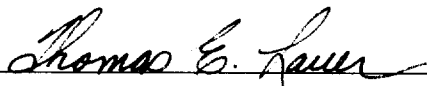
An Honors Thesis (HONRS 499)

By

Andrea Beier and Melissa Jones

Thesis Advisor

Thomas E. Lauer, Ph.D.



Ball State University

Muncie, IN

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Abstract

The objective of this study was to compare Index of Biotic Integrity (IBI) with Qualitative Habitat Evaluation Index (QHEI) scores of Bell Creek, Delaware and Henry IN counties. Twelve sites were chosen spaced approximately evenly along Bell Creek from the mouth upstream to the headwaters. At each site, we evaluated the aquatic habitat using standard QHEI methodology. Collecting fish samples followed IBI protocol and used a backpack electrofishing unit. IBI scores were lowest at the most upstream station, while scores downstream ($>3.6 \text{ mi}^2$) appeared due more to changes in other aspects of the habitat, as defined by the QHEI score for that particular site. Thus, lower IBI scores in our sample may be due to low QHEI scores calculated at sites that had previously been channelized or influenced by other anthropogenic events. This suggests that habitat has a greater influence on IBI scores than drainage area and current IBI methodology may need to be reevaluated based upon habitat classification.

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Introduction

Regulatory activities under the Federal Water Pollution Control Act of 1972 and its 1977 and 1987 amendments require knowledge of the potential fish or biological community that can be supported in a stream or river. A procedure for relating stream potential to habitat quality would provide some insight into how habitat might affect biological expectations in a given water body. However, until just over a decade ago, a formal and comparable assessment of habitat was not available. Rankin (1989) developed the Qualitative Habitat Evaluation Index, or QHEI, that did just that by providing a measure of the qualitative habitat corresponding to the physical features that affect fish and invertebrate communities. QHEI exists, but has not been applied widely.

Describing the type and quality of a fish community in a stream has also been difficult to achieve until recently. A number of tools have been used for assessment and include: species richness, species diversity, index of well-being, multivariate analysis, and, most recently, the Index of Biotic Integrity, or IBI. IBI is a tool used to assess the health of aquatic ecosystems relative to the abundance and diversity of species of fish found within a given site. Unlike other methods of biological assessment, IBI methodology allows some degree of comparability throughout a geographic region or drainage basin (Karr 1981). IBI scores can be used to address the issues outlined in the Federal Clean Water Act Amendments of 1987, which allow for the development of biological criteria in order to evaluate the quality of our nation's surface waters. The

methodology is fairly uniform throughout the United States, and thus it is commonly used by pollution control agencies such as the EPA, or in this state, the Indiana Department of Environmental Management. IBI is currently the most commonly used, and arguably the most effective, means of quantitatively measuring biotic integrity.

Field truthing of the methodology, however, is required, and some adaptations may have to be made depending on local conditions. The IBI for this region in Central Indiana, otherwise known as the Eastern Corn Belt, was developed by Simon and Dufour (1998), which includes Bell Creek in Delaware and Henry counties.

The presence or absence of organisms in a stream is strongly related to the physical and chemical characteristics of that stream. Therefore, the objectives of our study were to identify the relationship between habitat and fish community structure as defined by QHEI and IBI, in Bell Creek, Delaware and Henry counties, Indiana, and to provide a list of fish species diversity for taxonomic record.

Methods and Materials

Twelve study sites were chosen along Bell Creek, Henry and Delaware counties, Indiana, from the headwaters to the mouth (Figure 1). The sites were approximately one mile from each other, with six being in Henry County and six being in Delaware County. All sites chosen were based on access availability, typically found at road crossings. Bell Creek is approximately 38.8 km in length, with a drainage basin of 116.5 km². The basin consists of mostly agricultural areas, however some urban areas are also present.

The physical habitat at each site was then evaluated using the Ohio Environmental Protection Agency's Qualitative Habitat Evaluation Index (QHEI) procedure (Rankin 1989). All sites were evaluated in either March or April 2001 and re-evaluated in

September 2001, as well as January 2002. Each time, investigators started at the mouth and worked their way upstream. Scores from the three evaluations were consistent with each other. The lack of aquatic macrophytes in September and October 2001 caused a decrease in scores when compared with the previous spring. In this case, scores from March and April of 2001 were used.

Fisheries communities at each of the twelve sites were evaluated using the Index of Biotic Integrity (IBI) protocol (Simon and Dufour 1998) in September and October 2001. A backpack electrofishing unit was used for all stations, with two or three additional individuals netting fish. Species were identified and the length, weight, and delt anomalies for each individual were recorded on site for larger fish, while smaller fish and those not identified in the field were preserved in 5% formalin and returned to the lab for processing. IBI calculations for each station were generated from these data, according to the scoring methodology of Simon and Dufour (1998).

Results

Thirty species were identified within Bell Creek. The most common species included the creek chub (*S. atromaculatus*), the central stoneroller (*C. anomulum*), and the mottled sculpin (*C. bairdi*). The most unusual species included the blackside darter (*P. maculata*) and the striped bass (*M. saxatilis*). No rare or endangered species (as classified by the Indiana Department of Natural Resources) were collected.

QHEI scores for the 12 sites on Bell Creek ranged from 48 to 83. Low scores at the headwaters (e.g. 200W and 300W) were a result of limited in-stream cover and poor pool, riffle, and run quality (Figure 2). Scores improved at sites 650N and 750N because of improved cover within the stream bed and better development of riffle, run, and pool

habitats. A considerable drop in QHEI scores occurred at 850N in Henry County. Here, anthropogenic influences (mainly agricultural) occurring around and within the stream reduced riparian zone areas and eroded banks. The highest score occurred at 950N, where an adequate amount of in-stream cover was present, channelization had not occurred, and pools and riffles were well developed. The lowest QHEI score was recorded at 700S. Channelization of the stream greatly impacted this site, creating bank erosion and large amounts of silt cover. The floodplain for both banks consisted of row crops, thus reducing riparian zone area. Great variations in QHEI scores were seen throughout the watershed.

IBI scores for Bell Creek range from 26 at the headwater streams to 44 at Honeycreek Road in Delaware County. Low scores at the uppermost station are due to a lack of flow, thus contributing to the small number of species found and low catch per unit effort (CPUE). Scores noticeably increased at 300W as the number of species found and the CPUE improved greatly. IBI scores continue to increase until 850N where a dramatic decrease in the quality of the fish community occurs. Sensitive species and lithophilic spawners are lost at this site, most likely due to habitat degradation. Scores are highest at Honeycreek Road, where the proportions tolerant species and omnivores are low and the percentage of insectivores is greater than 50%. IBI scores fluctuate between 28 and 38 toward the mouth due to changes in fish community structure and habitat quality.

No significant relationship exists between QHEI scores and IBI scores along Bell Creek ($p = 0.284$, $R = 0.337$) although the six middle sites (e.g., 750N to 600S) may demonstrate a possible correlation between these two methods of evaluation, as the

scores of each appear to ascend and descend together. However, great variations in the data and low sample sizes have not produced any correlation.

Discussion

Index of Biotic Integrity scores for Bell Creek are similar to those of local watersheds of similar size in the Eastern Corn Belt region of Indiana (Simon and Dufor 1998) and are indicative of a typical diversity and richness of species that occupy disturbed warmwater habitats. A reduction in IBI scores due to shifts in the community structure of species from intolerant to tolerant in the middle sections of the stream appeared to follow degradations in habitat quality, as measured by the QHEI. However, variations in the most upstream and downstream areas appear to be influenced by factors other than the physical habitat. These factors include the following:

Water Quality

Water quality parameters were not taken in this study. However, observation of land use activities along the watershed may provide some insight into the degradation of water quality along Bell Creek. Two major land-use impacts should be noted:

Agriculture—Many sites along Bell Creek fell within agricultural land. At these sites (i.e. 850N and 400S), IBI scores appeared to be sensitive to this change in land use and decreased accordingly. Roth et al. (1996) has noted that IBI scores may decline solely because of agriculture when more than 50% of the watershed was devoted to this practice. A recent Section 319 pollution grant (2000) for the upper White River explains that Delaware County soils are poorly drained and are marked by extensive tile drainage systems. Thus, nutrient loading, especially due to phosphorous and ammonia, is of

special concern within this county. The watershed of Bell Creek is most likely plagued by the same problem.

Agricultural pesticides are also a significant source of non-point runoff in Delaware County. Recently, a citizens monitoring group found seven different metabolites and pesticides in a single glass of Muncie's treated drinking water (Bothel 2000). These include atrazine, cyanazine, metolachlor, alachlor, simazine, desethylatrazine, and desisopropylatrazine. These same seven pesticides are probably found within Bell Creek. The effects of this type of pollution are probably seen as an increase in the proportion of omnivores (i.e., common carp and white suckers) and tolerant forms (i.e., green sunfish and blacknose dace) and a decrease in species diversity and CPUE.

Sedimentation due to tillage operations and subsequent soil erosion has also been cited as a major concern with respect to water quality within Delaware County (Bothel 2000). A USEPA report conducted in the Upper White River Watershed from 1980-1993 asserts need to reduce sediment loading into the White River through erosion reduction on farm fields (Bothel 2000). The effects of sedimentation are probably seen within the Bell Creek watershed as it reduces visibility for many predator species and destroys delicate lithophilic spawning habitat for species such as the logperch (*P. caprodes*), striped shiner (*L. crysocephalus*), and northern hog sucker (*H. nigricans*).

Private septic systems—All homes within the Bell Creek-No Name Creek Watershed use septic systems (Johnson 2002). A Delaware County Soil Survey reveals that septic systems are of a major concern within the county as the soils are unable to fully filter human waste and are severely limited for septic system use (Bothel 2000).

Septic system failures are common within Delaware County, especially near the mouth of Bell Creek (Johnson 2002). Within these areas, IBI scores are depressed, most likely due to the presence of more tolerant species. The proportion of tolerant forms at SR67 and 400S compose almost 25% of the species community found at these sites. Thus, the presence of pathogens and an increase in nutrients may be further compounding water quality issues at the mouth of Bell Creek.

Fish Migration

No barriers exist in Bell Creek or downstream in Buck Creek and the White River that would impede fish migration along this corridor. Additionally, the distance between the mouth of Bell Creek and the White River is only 5.73 kilometers. Thus, during environmentally stressful periods, fish may easily move up or downstream seeking relief. At the headwaters at 200W, only 6 species were found with a CPUE of 24 individual fish per 15 wetted widths of the stream segment primarily due to low flow at that site. Sampling at this same site during periods of increased flow would most likely show greater species diversity and richness due solely to fish migration to that area. Similarly, the number of species (8) and the CPUE (70 fish/15 wetted widths of the stream segment) were low near the mouth of Bell Creek at Jones Road. Sampling at low flow periods may change this number.

Flow

As stated above, the low IBI scores at the headwaters of Bell Creek are likely due to low flow conditions. Flow is an abiotic habitat characteristic that may determine the presence or absence of some fish species. For example, johnny darters (*E. nigrum*) are typically found in the riffle areas of a stream. Similarly, the niche for many aquatic

insect species that serve as prey for insectivorous fish may be defined by particular flow characteristics. In addition, flow may *indirectly* impact fish populations by affecting other habitat factors such as water temperatures and water quality (Kohler and Hubert 1999). Variations in species composition at the headwaters may occur seasonally as these areas may dry up during the summer months where rainfall is limited or swell with the melting of snows in the spring (Cole 1979). The flow regime of the watershed is also affected by channelization and the removal of essential habitat (i.e., woody debris and undercut banks) from the stream, creating a greater efficiency of streamflow. As previously mentioned, fish will migrate to and from regions of little to no flow or degraded areas. Thus, the characteristics of flow along the watershed and the ability of fish species to throughout the watershed with relative ease may explain the low IBI scores at the headwaters.

Random Sampling Error

Only 12 sites were sampled along the Bell Creek watershed. A small sample size such as this yields little statistical power. Future studies may include both QHEI and IBI scores from sites of similar drainage area located within the Eastern Corn Belt. Also, an assessment of water quality and the inclusion of benthic organisms may help to further define the relationship between aquatic organisms and their habitat.

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Table 1. Fish species found in Bell Creek, Delaware and Henry counties IN in September and October 2002, all stations combined.

Common Name	Scientific Name	Number Collected
Grass pickerel	<i>Esox americanus</i>	3
Common carp	<i>Cyprinus carpio</i>	8
Creek chub	<i>Semotilus atromaculatus</i>	185
Hornyhead chub	<i>Nocomis biguttatus</i>	1
Blacknose dace	<i>Rhinichthys atratulus</i>	26
Emerald shiner	<i>Notropis atherinoides</i>	6
Sand shiner	<i>Notropis ludibundus</i>	39
Central stoneroller	<i>Campostoma anomalum</i>	278
Bluntnose minnow	<i>Pimephales notatus</i>	84
Striped shiner	<i>Luxilus chrysocephalus</i>	24
White sucker	<i>Catostomus commersoni</i>	21
Creek chubsucker	<i>Erimyzon oblongus</i>	32
Northern hogsucker	<i>Hypentilium nigricans</i>	22
Yellow bullhead	<i>Ameiurus natalis</i>	7
Blackstripe topminnow	<i>Fundulus notatus</i>	17
Mottled sculpin	<i>Cottus bairdi</i>	278
Banded sculpin	<i>Cottus carolinae</i>	46
White bass	<i>Morone chrysops</i>	1
Rock bass	<i>Ambloplites rupestris</i>	16

Green sunfish	<i>Lepomis cyanellus</i>	55
Bluegill	<i>Lepomis macrochirus</i>	4
Orangespotted sunfish	<i>Lepomis humilus</i>	7
Longear sunfish	<i>Lepomis megalotis</i>	25
Redear sunfish	<i>Lepomis microlophus</i>	13
Smallmouth bass	<i>Micropterus dolomieu</i>	9
Orangethroat darter	<i>Etheostoma spectabile</i>	24
Johnny darter	<i>Etheostoma nigrum</i>	47
Greenside darter	<i>Etheostoma blennioides</i>	19
Rainbow darter	<i>Etheostoma caeruleum</i>	38
Logperch	<i>Percina caprodes</i>	4

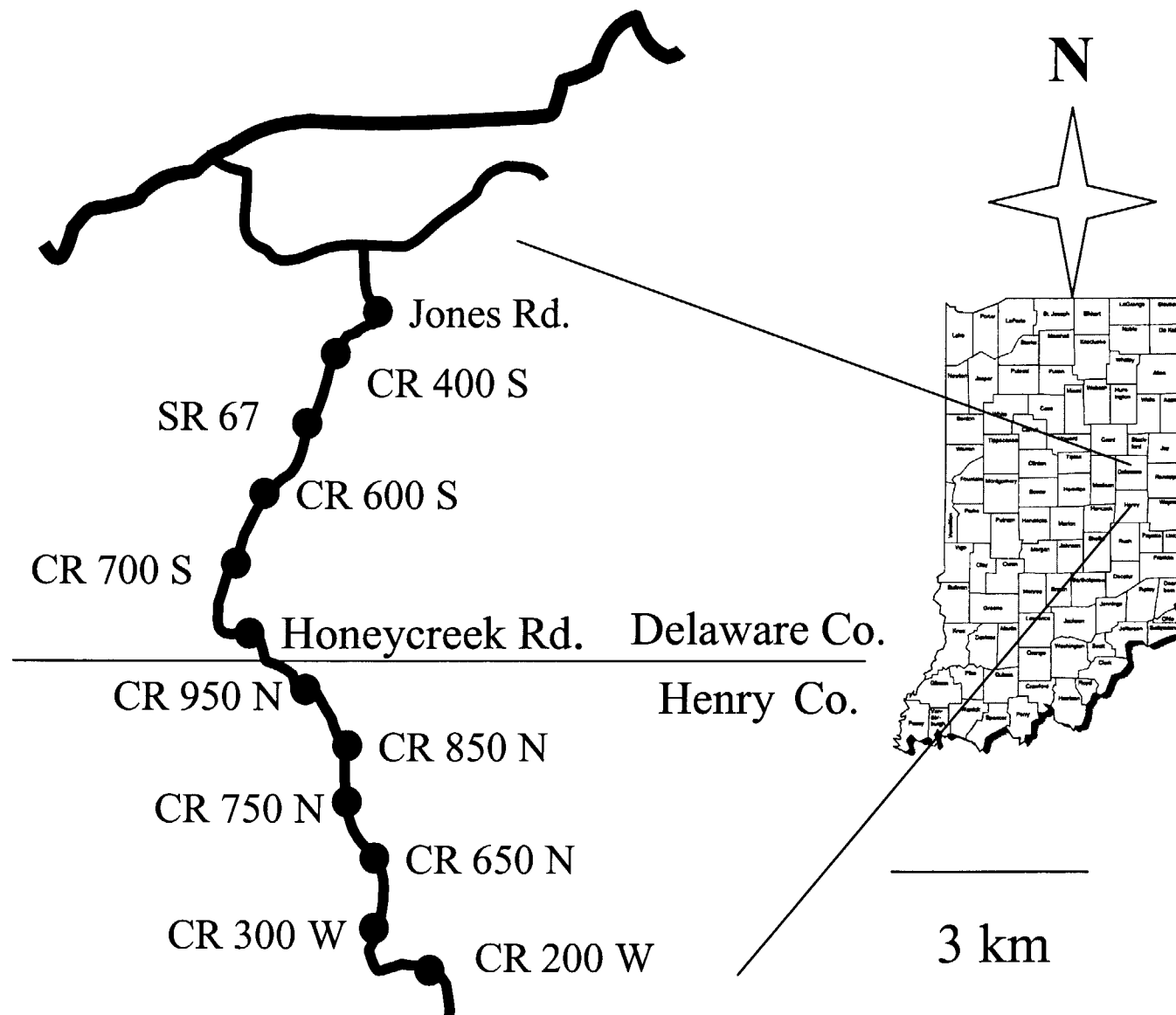


Fig. 1. Sample site locations on Bell Creek, Delaware and Henry counties, IN.

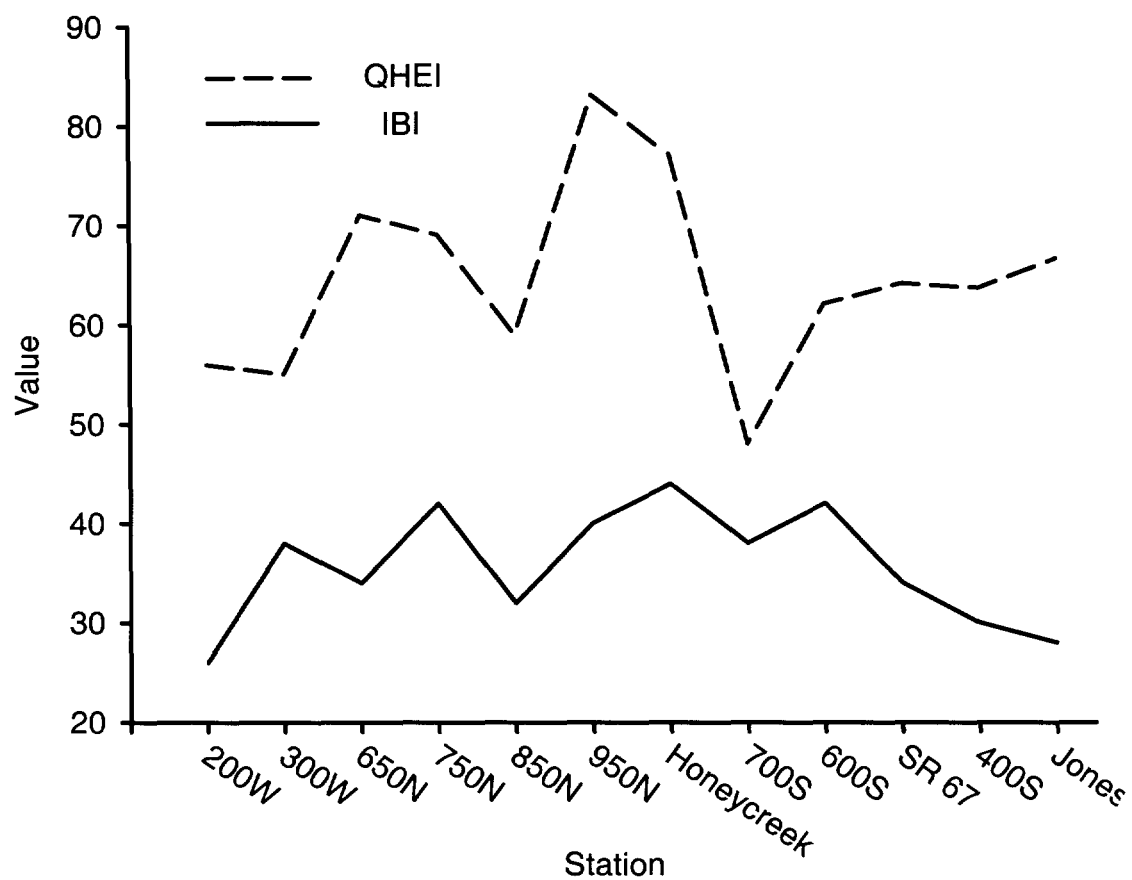


Fig. 2. IBI and QHEI scores for each site on Bell Creek, Delaware County IN from the headwaters (200 W) downstream to the mouth.